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ABSTRACT

Reasons for increased interest in higher education-economic development relationships are reviewed and the nature of the guidance that policy analysts may be able to provide decisionmakers is outlined. Attention is directed to the merits and drawbacks of six possible approaches to increasing higher education's contributions to economic development without spending large additional sums of state tax dollars. Emphasis is given to two types of approaches used in Washington State: additional investments in technology transfer of university research and development and additional support for campus-based technical and management assistance to firms. Two types of technology transfer investment strategies were studied. The applicability of the approaches to colleges and universities seeking to enhance their contributions to rural economic development are assessed. It is concluded that programs with this objective need to have some special emphases designed for the contemporary rural context, and that expectations for their impact should be modest. It is recommended that attention be directed to objective data-gathering and independent assessment of the impacts of campus-based economic development efforts. (Author/SW)

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INCREASING HIGHER EDUCATION'S CONTRIBUTION TO ECONOMIC DEVELOPMENT IN URBAN AND RURAL COMMUNITIES: LESSONS FROM WASHINGTON STATE

by

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Current interest in increasing demonstrable linkages between public expenditures on higher education and economic development is high (Johnson 1984, Office of Technology Assessment 1984, SRI 1986). While there is interest in this topic at both the local and federal levels of government, the emphasis is probably strongest at the state level from which most of the tax support for higher education comes and to which much of the political responsibility for the relative pace of economic growth has shifted in recent years. In this paper reasons for the increased interest in higher education-economic development relationships are reviewed and the nature of the guidance policy analysts may be able to provide decisionmakers in light of the relative dearth of strong evidence on the effectiveness and efficiency of alternative strategies is outlined. An analysis is presented of the evident merits and drawbacks of six plausible approaches to increasing higher education's contributions to economic development without spending large additional sums of state tax dollars. Special emphasis is given to two types of approaches examined closely by the author in Washington state. These two approaches are: (1) additional investments in technology transfer of university R&D (two distinct types of technology transfer investment strategies were studied), and (2) additional support for campus-based technical and management assistance to firms. Next, the applicability of these approaches to colleges and universities seeking to enhance their contributions to rural economic development are assessed. This analysis concludes that programs with this objective need to have some special emphases designed for the contemporary rural context, and that expectations for their impact should be modest. Finally, a plea for additional attention to objective data-gathering and independent assessment of the impacts of campus-based economic development efforts is made.

Why the Increased Interest in the Economic Development Contributions of Higher Education Now?

The relationship between the education level of the labor force and economic growth is now well-

established. More educated workers earn substantially more than do workers with less education even after taking account of, to the extent possible, other factors correlated with both education and earnings (Becker 1975; Cohn 1979; Haveman and Wolfe 1984; Solmon 1985). The most authoritative estimate of the contribution of growth in education to U.S. economic growth (over the period 1919-1982) places this contribution at 14 percent of the total growth if only gains in labor force education per worker are counted, or 42 percent if "advances in knowledge" relevant to production are also counted (Denison 1985). Recent studies that have attempted to pinpoint the impact of quality of education (mainly higher education) on earnings and economic growth have also found strong positive effects. (See the literature reviewed in Solmon 1985.)

Not surprisingly, there is strong empirical evidence that firms place a high priority on proximity to academic institutions in their formation and location decisions (see especially Office of Technology Assessment 1984: 18-40, 56-57; Malecki 1987: especially pp. 22-24 and Tables 1 & 2). This is particularly true for research-and-development-intensive facilities and is true to a considerable extent also for such high-growth employers as technology-intensive production facilities (OTA 1984: 28-40) and high-wage producer services[1] firms (Beyers et al 1986).

Beyers et al's 1985 and 1986 firm survey data on the Puget Sound region shows the producer services industry group to be a critical engine of that region's recent and likely future economic growth -- producing a high percentage of all Puget Sound region job growth during the 1970's and 80's (Beyers et al 1985: 1-9) -- and one closely tied to higher education.[2] Since producer services firms have much higher proportions of their work force in professional, technical and managerial occupations than do manufacturing firms (roughly 43 percent versus 11 percent), they require educated workers and continuing education opportunities for these workers in order to grow, and are very concerned about education quality (Beyers et al 1986: iii, xi-xiii).

As the studies alluded to above suggest, the economy is changing rapidly in ways that make postsecondary education even more central to economic growth than it has been in the past. This country is

[1]The "producers services" industry group is defined by Beyers et al (1986) as firms providing services to other firms or government and includes finance, insurance and real estate firms; architecture and engineering firms; law and accounting firms and management and computer/information systems consulting firms; health, education and training services; research, development and testing services; and transportation, communications and utilities services; as well as various specialized and miscellaneous business services.

[2]The Puget Sound region's producer services firms are fairly typical of large urbanized regions in the U.S.; if anything their growth has been somewhat less vibrant in this region than elsewhere.

losing or has lost its competitiveness in many manufacturing activities as most business activities (including both production and marketing aspects) have become more internationally competitive with declining transportation and communication costs. Interregional competition within the U.S. for markets and jobs has increased as well for much the same reasons. At the same time, the rate of technological change in many products and services and in processes for providing them (e.g., computerization) has accelerated sharply. These conditions create both a challenge and an opportunity for the U.S. (and especially for export-oriented states such as Washington). Our competitive niche in the "new international economy" is almost certain to lie increasingly in providing the R&D behind new processes, products and services and their initial production and marketing, and less than in the past in long-term, large-scale production of established products using established technologies. In the increasingly competitive world economy these types of routine production activities are continuing to show a tendency to migrate to low-cost regions of the nation and world.[3]

In such an internationalized, technology-oriented and rapidly-changing economic environment high-quality colleges, universities and technical training institutions take on a new level of importance. They are of course the source of the initial education and training of key components of the higher-quality work force successful firms need in the competitive new economy.[4] But they must also be prepared to provide the increasingly necessary continuing education and retraining required by a skilled work force that needs to be at, or at least able to cope with, the cutting edge of change. This applies to regions seeking to diversify a narrow economic base or to revitalize via new technology traditional industries where markets have become more competitive, as well as to the already technology-intensive regions.

Contributions of Higher Education to Economic Development Via Research and Technological Equipment and Expertise

The increasingly important role of high-quality postsecondary education and training to the nation's long-term economic future now holds the attention of opinion leaders and policymakers. The education and training

[3]Resource-based industries and manufacturing of products heavily dependent on local raw materials (which are very important in the Pacific Northwest) and/or local markets are less prone to these pressures, but even they face incentives to become more productive lest lower-cost competition from other regions and nations erode their established markets.

[4]A surprisingly large component of this work force consists of entrepreneurs (firm founders) themselves. This is so because new firm formations are so important in the new economy and new firms tend to be small (see Beyers 1986; Birch 1986), particularly in the fastest-growing industry groups.

of students is the role played by academic institutions that is best known and understood by them. But there are other important roles these institutions play, or could play, that are directly related to economic development. These are distinct from the education and training role, although closely related to it.

Research and technology-driven links between academic institutions and industry are increasingly important in the new economy if academic research is to be of maximum value to industry and rapidly utilized to improve processes, products and services. Universities and firms have increased, and even institutionalized, their interactions in recent years. Perhaps the best available single indicator of the increased industrial interest is the recent trend in industrial support of university research, which has grew at the University of Washington from $7.2 million in FY1984 to $11 million in FY1986, a pattern not untypical of many leading U.S. research universities.

Also of importance, faculty and other professional staff (and, to some extent, students) provide professional services, i.e., technical and/or management consulting and assistance, to thousands of firms each year, though the exact amount and impact of this diverse activity is impossible to document at present. There are some formal, campus-based programs of business and, to a lesser extent, technical (i.e., science/engineering-oriented) assistance (to be discussed more fully later), but much of the activity is informal or conducted outside the provider's university role entirely. Thus, it isn't measured, much less coordinated or systematically evaluated.

In addition, colleges and universities have valuable scientific and technical facilities and equipment, not all of which are utilized by campus users all of the time. At the same time firms, especially but not exclusively small, technically-oriented companies with limited resources but significant growth potential, have need of such facilities and equipment which they are often unable to purchase for themselves. Leanly-funded universities may obtain revenue from charges for the use of slack capacity in such facilities. Among other purposes, such revenues could be used for desirable maintenance and updating of the facilities themselves. Again, in most instances it is not known how much of this kind of mutually beneficial intensification of the utilization of existing resources occurs now (much less how much could profitably occur), since in few cases is it organized or monitored centrally. (Indeed, incentive structures within academic institutions may actually impede the development of such mutually beneficial transactions unless they are given explicit attention.)

Thus, science and technology-based firms, and to some extent firms in traditional resource-based or

manufacturing industries who seek to use new technology to improve productivity, have reason to favor locations near campuses, not only for the formal educational opportunities they provide but also for the proximity to research and technical expertise they afford. Not surprisingly, this affinity for the campus is strongest with respect to location of R&D facilities, but industrial location decisionmakers also find proximity to quality academic institutions desirable, if less critical, for manufacturing facilities. Indeed, the presence of such an academic institution seems to be a key ingredient in the occasional transformation of regions with substantial high-technology production plants but little if any dedicated R&D facilities into "seedbeds" of innovation (Office of Technology Assessment 1984: 28-40, 53-69). This is significant because it is the R&D facilities that tend to produce rapid growth via spinoffs and new start-ups as well as rapid growth of existing firms, while branch-plant production facilities of high-technology firms do less spinning off and have shown a tendency to be "footloose," i.e., quite ready to move when cost advantages shift.

The specific value to such firms of proximity to academic research may require some elucidation. Such proximity can provide a firm with a "window" on academic research in fields of interest to it. In addition, close ties to university departments or research institutes provide firms with access to faculty as research performers and consultants and to students as potential employees (Rees 1987). Institutions and departments, as well as firms and state governments, can do more or less to promote and institutionalize such relationships, as we shall see.

However, to the extent that a state or region's economic development strategy is built upon attracting existing technology-intensive firms to an area (rather than "growing its own" firms), it is likely to find this a very competitive market in which it is becoming increasingly costly to compete successfully. North Carolina's "Research Triangle" area (a geographic zone of considerable size including three major research universities and the Research Triangle Institute) is often cited as a success story, but its success took many years to build from a unique initial base and it now represents a very strong competitor (and not only one) for others seeking to emulate its accomplishments. Moreover, spinoffs of new firms from those attracted to this area have been few (Malecki 1987: 21-22).

High-Technology As a Source of Employment Growth

A second model for substantial technology-based contributions by academe to regional economic development has fewer elements of a zero-sum competitive game. This model, while not ignoring the attraction of firms new to an area or service to established firms with technology-oriented needs, focuses most directly on creating the conditions to become a seedbed for technology-oriented business start-ups and rapid growth. The logic of this strategy derives from the proven employment growth potential of high-technology, especially from new firm formations and growth of small, independent firms, in recent years.

Brookings Institution researchers prepared a report for the federal Office of Technology Assessment on the formation and growth of high-technology firms, defined to include certain business services as well as manufacturing firms[5] (Armington, Harris and Odle 1984). They compare various indices of growth in high-technology manufacturing and business services industries with growth in two other subgroupings: (1) "low-technology" manufacturing and business services; and (2) all other industries. Overall in the United States, they found that high-technology industries' employment grew by 19.4% over the 1976-80 period while employment in all industries grew by 15.2%. High-technology industries had an edge on this measure in all four of the regions into which they divided the country. For the Seattle Standard Metropolitan Statistical Area, the high-technology job growth rate (including the aircraft industry) was a remarkable 160.1 percent, compared to 41.7% for all industries (Armington et al 1984: 116).

In terms of sources of employment growth, high-technology manufacturing and business services led low-technology industries in these same categories in both employment growth as a result of new firm formations and growth as a result of firm expansion in all four regions. Significantly, net employment growth among high-technology firms was fastest among independently-owned firms (37 percent for the U.S. as a whole over the period), was second-fastest among local affiliates of companies headquartered in the same state (26 percent), followed by affiliates of out-of-state firms (18 percent), with owning establishments of multi-establishment enterprises growing slowest (8 percent). The fastest job growth rate of all (57 percent) occurred among

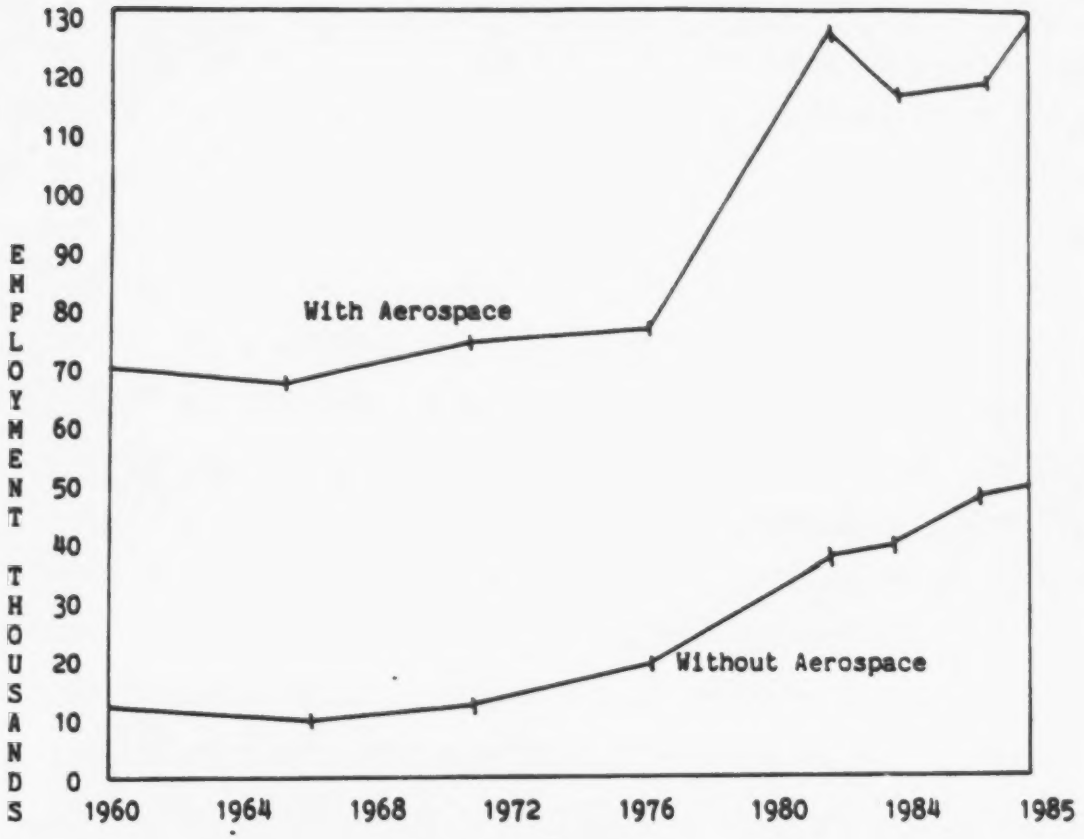
[5]There is no fully standard methodology for defining "high-technology" industries. The Armington et al methodology is a composite of techniques based on the share of employees in an industry group who are in scientific, engineering and technical occupations, and techniques based on R&D expenditures as a percentage of product value, with some special procedures for business services designed to focus on the truly "high-technology" group of these (Armington et al: 118-119).

independently-owned high-technology firms in the West, followed by such independents in the South (53 percent), with local affiliates of in-state firms in the West third (43 percent). Significantly also, among all industry groups employment growth was most rapid in the smallest category of firms (0-19 employees) and slowest in the largest category (100+ employees). High-technology firms with less than 20 employees were far and away the fastest growing subgroup of all with 70 percent job growth. These data give some indication as to why states and localities have sought ways to lure and support firms in high-technology industries in recent years (albeit few of their strategies until very recently have been aimed at small firms). An indication of the pace of high-technology employment growth in Washington state is given in Figure 1. In addition to aerospace, this employment is concentrated in inorganic chemicals, computer and data processing services, scientific, medical and controlling instruments, R&D laboratories, office and computing machines, communication equipment and electronic components (Washington State Employment Security Department 1985).

The "high-end" services industries (i.e., producer services as defined by Beyers et al above) in the Puget Sound region studied by Beyers and his colleagues not only show steady employment growth in the past and a sharp increase in their contribution to the region's crucial export base over the last two decades, they project a 31% five year employment growth rate over the 1984-89 period (Beyers et al 1985: 112). This represents more than 26,000

Figure 1.

Employment in Washington High Technology Industries, 1960-1985



SOURCE: Washington Employment Security Department. Employment and Payrolls in Washington State, quarterly, as reported in High Technology Coordinating Board 1985:10.

jobs (when multiplier effects are included more than 65,000) among just the 1,103 firms Beyers and company interviewed. (These firms represented about 30 percent of total service sector employment in the region.) Not all these firms are classified as high-technology, but many of them use computer and other rapidly-changing technology extensively, and they have important similarities to high-technology firms in terms of key workforce characteristics and requirements, especially in regard to education and training. (As noted earlier, the Puget Sound region's growth pace in this key sector is, if anything, lower than that in many other large metropolitan areas.)

Vital academic institutions are by no means the only ingredient in the mix required to sustain a seedbed for new firm formations and growth, but they are universally acknowledged to be essential. New firms in high-technology fields and, to a lesser extent, producer services firms are often founded by technical specialists with university affiliations or very recent university experience, e.g., as university graduate students or researchers (Beyers et al 1986). Beyers' research shows that a large majority of the recently-established producer services firms in the Central Puget Sound region were located there because the founder lived in the region, had no wish to leave, and found the business climate (including, as a major consideration, access to universities and university people) attractive (Beyers et al 1985 and 1986). These founders usually did not seriously consider establishing their new businesses elsewhere; their real choice was between establishing the new venture where they were or continuing to make their living by working for someone else in the same region (and thereby creating fewer new jobs). Access to appropriate educational institutions was clearly the most important factor in maintaining growth in this critical sector of the modern economy (Beyers 1986: ii-iii).

While we found no similar study of high-technology product firms in Washington, the literature suggests that their founders' decision processes are probably similar. The would-be entrepreneur -- often a recent university graduate, postdoctoral researcher or even faculty member -- could make a good living in a number of ways and would rather not leave the region; the question is whether he/she will view the economic climate and available support resources as adequate to start a new venture.[6] Econometric analysis of the determinants of business formations and employment growth by Armington et al (1984) showed that "the quality of the labor supply and the pool of potential entrepreneurs, as measured by the proportion of workers using scientific and technical skills," in a region were strongly related to high-technology business formations, much less so to firm start-ups in low-technology industries, and not at all to other business start-ups (Armington et al 1984: 133). The relationships were similar with respect to explaining net employment growth though less strong, apparently because so much of the employment base is in already-existing facilities (Armington et al 1984: 134). Empirical analysis by Malecki (1987: 11-12) of new firm formations in four high-technology sectors during the 1978-83

[6]Surprisingly, for many of these new firms the size of the local market is not the primary consideration (Beyers et al 1985: 55). This is because both high-technology product firms and many producer services firms are heavily involved in "export" markets, i.e., sales outside the region (OTA 1984; Beyers 1985: v-vi). Of course, from an economic growth standpoint, such firms are especially desirable because their export sales bring new purchasing power into the region.

period produced results similar to those of Armington and her colleagues.

Implications For State Policy

Because they operate in fields where technological progress is rapid, new technology-based firms need university-generated research and knowledge and university-based consultants and educational opportunities (including conferences and informal sessions as well as formal courses and programs). Also among their most critical needs in the crucial early stages of their life are ready access to low-cost management (financing, marketing, business planning, etc.) and technical help. These are areas in which academic institutions -- and not just the "research" universities -- could help more than most of them now do, as we shall explain shortly.

The dramatic recent increase in efforts in many states in helping to forge and consolidate links between higher education and economic development is notable. Without being large in quantity, new state funds can serve as an important symbol of a state's commitment to working partnerships among academe, industry and government. If carefully targeted for incentive purposes and properly evaluated and adapted on the basis of experience they ought to be able to increase the level of economically productive activity undertaken by the two "operating" partners (institutions and firms). Data from a recent opinion survey of cognizant university officials at its member institutions by the Association of American Universities strongly support this view (AAU 1986), as does a wealth of more anecdotal evidence reported in the literature. Specific examples are provided in the next section.

In the course of the research underlying this paper, the outpouring of recent literature on higher education and economic development was reviewed in detail, as well as some of the related work on economic development generally. Scores of specialists and program administrators in the higher education and economic development business in Washington and around the nation were interviewed (mostly by telephone) or tapped through an exchange of correspondence. (See list of sources consulted.)

This search produced no shortage of plausible ideas as to what has been or might be done to increase higher education's connections to industry and economic development, though it was disappointingly short in producing evidence as to impacts in relation to costs and as to what works best under which circumstances. (Such studies should constitute an important part of the agenda for future applied research in the field.) To be fair, it should be noted that the field has been relatively neglected for a long time and new policy initiatives have been in

place only a short while.[7] Still, it is remarkable how limited the attention given to impact assessment has been, especially given that scarce state funds are involved.[8]

In most cases (certainly in Washington) state governments confronted with severe fiscal uncertainties and growing demands for services and money from multiple constituencies as federal support has declined are especially attracted to policy initiatives that promise economic development results in return for relatively little additional state expenditure. This constraint colors the context in which policy analysts should pose the standard questions in appraising, a priori, what measures a state ought to take, if any, to stimulate economic development through higher education. These questions are: (1) Which of the proposed measures are likely to produce over the long run societal benefits that exceed properly calculated opportunity costs?; and (2) To what extent are expenditures by government required in that societally justified investments would not occur in the absence of government involvement? In the absence of reliable data to answer the first question a priori, one might propose to proceed by looking for promising-looking measures that could be put in place at low cost and then evaluated before committing large sums. Also, one might look for measures that permit the state's funds to leverage funds from other sectors to achieve economic development goals. Finally, the analyst must consider carefully for each proposed measure whether the state's funds are truly necessary to elicit the desired behaviors and investments, or whether they could be expected to occur in any case. This analytic strategy is an effort to be responsive to the widespread concern with costs already mentioned and to policymakers' understandable reluctance to venture into new spheres of public subsidy to private firms.

The policy analytic effort described below was carried out for elected officials in the state of Washington with these criteria in mind. This project was not an effort to develop deep new insights or theory on the nature of higher education's contributions to economic development. Rather, the idea was to review, sift and apply existing theory, and to gather such evidence as data availability and modest resources permitted in order to find

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[7]The literature is clear on one point -- that dramatic results in terms of jobs and economic growth from new investments will often take years to materialize. North Carolina's Research Triangle, an effort begun in the 1950's, and Stanford's critical but long-developing impact on the emergence of the Silicon Valley are often cited to illustrate this point. It will be interesting to see over the years if state governments are willing to wait a long time for major results.

[8]Cynics (or perhaps realists) might argue that the lack of attention and resources given to collecting base line and other data necessary for future evaluation occurs because most of the parties are well served by the new programs and expenditures but might not be by what rigorous evaluation might show.

promising, low-cost avenues for enhancing higher education's contribution to a particular state's economic development.

Generalizability of the Findings

Though this analysis was designed for a particular state's circumstances, the analysis and findings are, broadly speaking, quite generalizable. The discussion of types of higher education-based economic development strategies in the next section is largely generic. The closer examination of two approaches found to be particularly applicable to Washington's circumstances also provides ideas that are at least worthy of consideration in other states. What is more specific to Washington, of course, are the judgments rendered here about the likely cost-effectiveness in a particular context of the specific approaches endorsed for immediate attention from the Washington Legislature, compared to the others relegated to lower priority status. These judgments were based on -- in addition to judgments about the general prospects for effectiveness of the particular types of strategies involved -- assessments of local institutional factors related to existing capacity, cost and ease of implementation which are likely to vary with circumstances in particular states. Also, due to variations in the strategic prospects faced by industries and institutions in particular settings, even assessments of the effectiveness of particular types of strategies will be to some extent context-specific.

In short, as policy analysts have learned in many other areas, context-specific strategic analyses and implementation assessments are a critical supplement to general principles derived from theory or from empirical observation across many data points if analytically-based decision criteria are to be useful in the real world of public policy.

Specific Measures States May Adopt

In any case, based on expert assessments of existing programs and such theoretical perspectives as could be drawn from the literature and interviews, the potentially large field was narrowed to some half a dozen categories of state initiatives that seemed most plausible as strategies for producing economic development benefits. The two categories with the most immediate promise in Washington were researched in most depth and form the basis of the discussion in the section following this one. The other four types are described below along with a brief analysis of their apparent attractions and potential drawbacks.

Selective State Subsidies for Customized Job Training

There are some attractive-looking operating models (though little rigorous evaluative data) in several states of programs that provide state subsidies for employee training and retraining selectively to firms who satisfy certain criteria (Arthur Young and Company 1985; Indiana Department of Commerce undated, Washington State Commission on Vocational Education 1986). The providers are sometimes academic institutions, often community colleges or vocational-technical institutes, since these are the types of institutions most likely to be able and willing to provide job-specific training.[9] The criteria a firm must meet to qualify for state subsidies typically involve a showing that, without the training, jobs would be lost to the state, either because the firm will not locate in the state or because, if already located there, will move to where trained workers are available or simply go out of business. While the precise criteria and machinery for choosing among applicants clearly need to be carefully thought out, reports from California, Minnesota and other states (Leigh 1986) do at least suggest some reason for hope that positive results for a state's economy can be achieved without placing insupportable demands on the public fisc.

In several states, community colleges are reported to be quite aggressive purveyors of job training to local firms, and in Arizona and Illinois at least, community-college-provided, state-subsidized job training is sometimes an important part of the package the state uses to attract new firms (Jaschik 1986). This does not seem to be the case in Washington as the state's "Job Skills Program" has remained quite small since its inception, apparently because of limited employer demand. Washington's postsecondary institutions provide some contract training, including unsubsidized as well as subsidized training, to local firms (State Board for Community College Education 1986), but the volume of activity seems to be quite limited. Six percent of the 1985-86 community college full-time-equivalent enrollment was supported through contracts. Given that preventing (as well as alleviating) unemployment is a high state priority and that other states provide job-training subsidies to firms that might otherwise stay or locate in Washington, this area of potentially increased higher education-economic development linkage will likely get additional attention in Washington and elsewhere.

[9]Four-year colleges and universities, however, might sometimes be appropriate providers for certain types of courses. In any case, the typical pattern in these programs is for the employer to select the provider, which need not be a postsecondary educational institution at all.

Training subsidy programs have, however, at least two generic problems. First, from a national policy perspective there is a clear danger that competing states will simply bid against each other with tax dollars to attract or retain firms that would (unless they have real location options abroad) locate within one of them anyway. Except to the extent that such state subsidies actually increase the total of productive human capital investments that firms would not otherwise make somewhere, they are simply unproductive "beggar thy neighbor" bidding wars that bribe firms to retain jobs.

Second, as many legislators sense, it may well prove difficult in operating these programs for public agencies to identify compliance with and be strictly true to the stated criteria about jobs otherwise being lost to the state. How does an administrator or oversight board know if a firm would actually lay off workers or move elsewhere, as it must represent in its application, if it fails to receive training subsidies from the state? Once these criteria are significantly relaxed political pressures to subsidize a wide range of formerly fully-privately-supported training will likely emerge and costs will skyrocket. Washington's Job Skills Program seems to have held to quite strict criteria and, perhaps as a result, assists only 30 or so training programs and about 2,000 trainees per year.[10] The conclusion from a thorough study of programs and results around the country might well be that an appropriately targeted program of subsidies for customized job training has a role to play in a state's economic development strategy, but a modest one.

Campus-based Business Incubators

Business "incubators" are programs -- usually but not always including contiguous physical facilities -- designed to help nurture small businesses through the early, high-risk stages of their development. While individual programs vary, the major ingredients are usually subsidized space, subsidized access to basic business services (clerical, accounting, legal, computing, etc.) and, often, access to specialized services appropriate to the particular industries or technologies in which the incubator specializes. Campus-based incubators often specialize in nurturing new, technology-based firms, sometimes including or even focusing on those spun off from the institution's own research. (This is the basic idea of Washington State University's recently-established incubator

[10]Figures cited are for fiscal year 1986 and are from Washington State Commission for Vocational Education (1986). Program officials report little change in the scale of the program since its inception in 1983, evidently largely due to limited employer demand that can meet the strict criteria.

facility. Those associated with community colleges are less clearly tied to academic research.) An important attribute of campus-based incubators is proximity to the academic institution's facilities, to faculty and students as potential teachers, consultants and employees, and to its intellectually stimulating milieu generally.

As the proliferation of such incubators in recent years attests, this is a plausible concept.[11] On the other hand, the idea of publicly-supported business incubators also has some problems. Constitutional or statutory considerations aside, public subsidies to some firms while excluding others are always hard to justify. As indicated above, this also applies to customized job training, but the criteria that must be employed in the case of subsidies for infant businesses using innovative technologies -- long-term potential for profitability and desirable employment growth -- are even harder to apply objectively. Second, it is difficult to attract appropriate management talent -- which probably needs to be drawn from the ranks of experienced entrepreneurs with exciting alternative prospects on their own -- to run business incubators accountable to public authorities. Finally, though there appear to be at least a few success stories at individual campuses,[12] overall it is clear that high-technology-oriented incubators are in an inherently risky business where failure rates will inevitably be high. Public policymakers must ask whether public funds should be put at risk in such ventures. The answer of course must turn at least partly on the results of further investigation of the long-run success of existing campus-based incubator facilities, and on the determinants of any such success. Objective studies are also likely to document implementation difficulties arising out of the kinds of problems mentioned above.

Publicly-Subsidized Research Parks

The attractions of proximity to a campus, especially to a research-oriented campus, for industrial R&D facilities should need no further elucidation at this point. These facilities would, of course, bring with them jobs and other benefits, including possible manufacturing jobs arising out of R&D results. The main problem is that the attraction of R&D facilities has become a very competitive game, and, therefore, it is costly to play in it. To do so successfully today may well require state and/or local government subsidies.

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[11]See, for example, Atkinson (1986) for a discussion of the history of incubators and their university origins.

[12]Georgia Tech and Rensselaer Polytechnic Institute (New York) have state-funded on-campus incubators that were reported to have produced, since 1980, 350 and 375 jobs and "graduated" two and nine companies, respectively (Finholt and Kiser 1985).

Only a few research parks based in or near university campuses have been in operation more than a decade, but some eighty are now in the operational or construction phase and a recent national meeting of the various types of parties interested in research park ventures attracted representatives from about 400 interested campuses. One has to wonder if university-based technology has become so important so rapidly to enough firms to soak up such rapid increases in campus-based research park space on the market. At minimum, such an environment will require that successful competitors perform their assessments of their own strengths and weaknesses and the strategies necessary for success very thoroughly and objectively. Some undoubtedly will not realize satisfactory returns on their initial investments as is evidenced already by reports of space going begging in existing research parks. Policymakers should be able to benefit from the experience of Washington State University's new Research and Technology Park, which is attempting to get established with little or no direct public subsidy. This experiment will be watched with interest and the reasons for its outcome, success or otherwise, should be evaluated as the evidence emerges.

State Subsidies to Encourage University-Industry Cooperative Programs

By "cooperative programs" here is meant such arrangements as personnel exchanges between university faculties and industry, student internships in industry, and departmental "affiliate" programs and the like whereby firms contribute funds in return for priority access to a department's research laboratories, people and results. There is a considerable amount of some of these activities already but it is quite unevenly distributed among campuses and science and engineering fields. Undoubtedly, explicit state subsidies for such cooperative efforts could make such programs more attractive to both parties (e.g., by helping to fund development costs or permanent administrative personnel), and thus should increase the level of activity. The question is whether this ought to be done.

Some observers express concerns that closer academic ties to industry could have large opportunity costs for society by restricting broad access to research results and by skewing research and teaching priorities away from the basic research that universities do best and nearly uniquely in society (Nelkin and Nelson 1985). To date there is little clear evidence of ill effects (see, for example, Blumenthal et al 1986), but safeguards and careful monitoring are clearly in order. The emphasis in these programs should be in putting slack capacity in the

universities to work in socially useful ways. Moreover, it is useful to distinguish -- as has not generally been done in the literature so far -- between academe-industry programs directed at research universities and those directed at other colleges and universities. Firms near research universities tend to look to them for partnerships because faculty expertise and research infrastructure may be greater, but many firms are not located near such institutions. Also, opportunity costs should be lower at these other institutions since fewer faculty and students are engaged in leading-edge basic research and since opportunities for summer and other outside support tend to be fewer. Yet the recent PhD surplus has placed considerable, often underutilized, talent in these institutions (Drew 1985).

The literature does suggest that arrangements that increase interpersonal interactions between university and industry people can pay important dividends over time (see especially Doyle and Brisson 1985: 1-5). In some institutions and departments, an earlier prevailing climate of academic isolation from industry has not been broken down. More, and more frequent, interpersonal contact and movement between the two milieux seems to be a necessary precursor of the kinds of formal, durable arrangements that can bring a department or research institute new resources, and firms and the economy the benefits of increased academic interest in bodies of knowledge with commercial potential.

The fact that some institutions and departments in appropriate fields have developed extensive contacts and cooperative programs with industry while others have not does not necessarily indicate that the latter could not do so or that the state should wait for the parties to act on their own. As long as there are public benefits (additional R&D output, ultimately better or cheaper products and employment growth) to be achieved that exceed costs of the modest subsidies that would probably be needed to stimulate the beneficial activities, the state is economically justified in providing help. Perhaps the primary targets should be departments or units with strength in seemingly appropriate fields but with very limited current contacts with industry. Perhaps the appropriate device is a competitive seed grant program requiring both success in an internal competition and success externally in attracting matching industry funds or services. Or perhaps direct support of entrepreneurial professional staff is a better bet if the basic problem is lack of such initiative or capacity at the unit level. Clearly, a good deal of discipline- and institution-specific design work is necessary before a potentially cost-effective program can be launched, but in general terms the prospects seem worth pursuing. In Washington, the

Washington Technology Center, to be described below, incorporates some aspects of this approach.

Highest Priority Areas: (A) Augmenting Campus-based Technical and Management Assistance and (B) Strengthening Technology Transfer Programs

As indicated earlier and developed more fully below, these two high-priority program areas meet the criteria of demonstrated success potential and ready applicability in the target state. Indeed, the necessary operating structures for the types of initiatives found promising in these areas were already largely in place on the state's public campuses. This would likely be the case in many other states as well.

Campus-based Technical and Management Assistance

College and university people, facilities and equipment can be of considerable value to business firms. Activities such as faculty and student consulting, faculty-administered student internships, and business seminars and short courses are used by many types of small and large businesses. But can state government provide the modest additional wherewithal necessary for colleges and universities to bring significantly more of their existing resources to the attention and disposal of a larger segment of business and industry? Can these resources be targeted especially to assist new or small firms, which we know are producing most new jobs and who often cannot find or afford on their own the management and/or technical (i.e., science/engineering oriented) assistance they need to grow?

Most colleges and universities can increase and better target management and technical assistance to firms if they are organized, staffed and provided with incentive to do so. Such help can be provided largely by better utilizing existing resources and need not detract from -- indeed it should add to -- institutions' performance of their central teaching and research missions by deliberately seeking to integrate with these and/or by concentrating on use of slack capacity on campus. The approach for doing this proposed here is based on a survey of programs operating in other states with features applicable in Washington and an analysis of the "infrastructure" of campus-based business assistance activities already occurring in Washington. (An analogous procedure would likely need to be followed in any state contemplating an improved effort in this program area.)

The findings from this research are reported in detail elsewhere (Zumeta and Stephens 1986). To summarize a great deal of information briefly, the key findings about strong and weak points in existing programs

and gaps in existing services that campus-based programs could help fill are here organized into a series of suggested design features for new state initiatives in Washington. These are listed and explained briefly below. They should be broadly applicable in other states as well.

- Technical and management assistance services (including use of campus facilities and equipment) should be integrated under a single administrative umbrella since many clients need both types of services and overhead costs can be cut in this way. In many states, campus-based technical (i.e., science/engineering-oriented) assistance services are quite underdeveloped.
- Effective publicity in the right places (i.e., local marketing) about the availability of the program and resources is necessary in many locales in the state. This will often require some new resources. One theme would be to promote an expanded business assistance program as a "front door" for small firms to university resources more generally.
- The program should be statewide in scope drawing upon all campuses with appropriate resources and interest (including community college campuses), but there is no obviously "right" lead agency or institution. The statewide headquarters of the Federal Small Business Administration's Small Business Development Centers (SBDC) program statewide headquarters is an obvious candidate in many states, though these centers often have little experience with technical assistance provision. Some states provide other models for central coordination (e.g., Michigan and Pennsylvania) that could be explored. In any case, full-time professionals on all campuses should not be necessary, though each participating campus should have a vehicle (local phone number, referral plan, etc.) for soliciting and responding to local client inquiries. The statewide office should focus on helping to match clients with campus resources outside their local area, organizational and administrative assistance to campus offices, statewide publicity, quality control and documentation of impact. Another activity to be conducted by the central office and the on-campus contacts is an active referral service to other organizations, public and private, that provide assistance to businesses. It is important for political as well as efficiency reasons that competition with private consulting firms be minimized and cooperation promoted.
- Target firms need not be strictly limited, but highest priorities should be those with the best growth

prospects and most need of unique campus resources, i.e., particularly small, technically-oriented product and service firms, at least in areas where those firms are numerous.

- In the interest of utilizing existing resources, keeping costs down and maintaining consistency with the educational mission, a key design element is to use faculty and students as much as possible in the actual delivery of services to clients. Thus full-time, nonfaculty professionals should function mainly in a marketing and coordinating role (i.e., soliciting clients and providers and matching the two), though in the interest of motivation and professional development they should probably also participate in client service activities to some extent. Faculty can sometimes be paid in teaching workload credit and students in academic credit, as in the SBA's Small Business Institute program. Where faculty or students must be paid in new dollars, there are good reasons to believe that many will be willing to provide their services at an effective cost well below the cost of supporting full-time professionals to provide most of the services. Faculty may also be willing to provide some services in return for use of project materials in teaching or research.
- Financial arrangements should subsidize target users without, in most cases, giving them free service (to reflect the mix of public and private benefits) and provide effective incentives to university units and people and their facilities and equipment to participate. Some "marketing" of the advantages of participation in the program to academic units and people is usually necessary, especially at the outset. The themes of such marketing should include emphasis on the educational and financial benefits for both students and faculty. For faculty the appropriate analogue may be medical school professional practice plans in which faculty are guaranteed access to clients without concerns about marketing and overhead, which are probably major deterrents to more consulting by faculty in other disciplines.
- Campuses and campus people are well-positioned to supplement state and fee support for a business assistance program with outside (particularly federal) support. Substantial federal support for activities of campus-based programs of management and technical assistance is available from SBA, the Economic Development Administration (EDA), and, for specialized programs, from other sources (e.g., Department of Energy, OSHA, Department of Transportation, etc.). This means that

state funds can leverage and complement federal funds, hopefully, for the benefit of all.

- An up-to-date computerized, statewide data base on faculty/staff capabilities and facilities and equipment availability is a plausible idea, but its cost-effectiveness needs to be investigated thoroughly since such data bases are known to be costly to design and keep up to date to meet client needs.
- The program should have an advisory board (probably with local campus boards) with representation from target firms and organizations, local chambers of commerce and economic development agencies, as well as from participating academic institutions. Visibility, quality control and flexibility to provide customized services can be facilitated in this way.

Enhancing Technology Transfer Efforts

"Technology transfer," as it is used here, refers to activities designed to increase the flow of research findings and technological developments from university experimental settings to commercially viable products and processes. This is socially desirable because it should lead to products and services that are better and cheaper than they otherwise would be, and thus to business enterprises that are more viable in the international economy and better able to provide jobs and incomes to the state's citizens. Broadly speaking, there are two avenues for increasing this flow of new technology from academe to the marketplace. First, we can take steps to increase the proportion of existing research results that are utilized (or at least considered) by industry and the speed with which they get considered. Second, it is possible to increase investments targeted at specific fields and projects with high commercial potential.

Strengthening Campus Technology Transfer Offices

In the early 1980s the federal government liberalized its policies in regard to university patent and copyright rights and prerogatives on inventions and discoveries accomplished with federal grants. Since then, most research institutions nationwide, including the University of Washington and Washington State University, have taken steps to enhance their efforts to encourage faculty inventions, patent and copyright applications on them, and commercial licensing of patented intellectual property (Association of American Universities 1986).

(Exclusive licenses, typically in return for royalties paid by the licensee to the university out of income from the new product, are usually thought necessary to induce firms to bear the costs and risks of product and market development.) Also, most universities began at this time establishing formal, campus-based offices of technology transfer for the purpose of soliciting invention disclosures from faculty, assisting with patent and copyright applications, and dealing with potential licensees (AAU1986). (Some of the licensing activity is still handled by contractors, but a much lower proportion than in earlier years.)

Table 1 compares the staffing and budget levels of the UW and WSU technology transfer offices in 1985 with those levels at universities with either comparable levels of research funding or membership on the Washington State Office of Financial Management's (OFM) list of peer institutions and the capacity to supply reasonably comparable staffing and budget data by mail or telephone. (The reader should note the Technical Appendix to Table 1 and succeeding tables describing definitional differences and the like that render any conclusions that might be drawn from them less than fully definitive.) It is clear that the Washington universities' technology transfer offices are minimally staffed relative to the comparably-funded research universities. Table 2 provides some indicators (for fiscal year 1985[13]) of the outputs from university R&D activity, indicators we would expect to also be related (at least in the long run) to expenditures for technology transfer. Again the Washington institutions rank quite low among their peers on all the output indicators.

[13]Data for two earlier years (1980 and 1982) comparable to that in Table 2 were developed and are reported elsewhere (Zumeta and Stephens 1986), but the Washington institutions' standing was little different in these earlier years.

Table 1

Technology Transfer Input Indicators
At Washington Universities and Comparable Institutions

University	Federal R&D Support (FY84) $ (Millions)	Rank	Tech. Transfer Employees (1985) $	Rank
(UW Comparison Group)				
Washington	137	3	2.3	6
U Cal System (Adjusted)	137	3	6.0	5
MIT	179	1	12.5	1
Stanford	160	2	12.5	1
Wisconsin	100	5	8.0	3
Michigan	95	6	7.0	4
North Carolina	48	7	2.0	7
Oregon	12	8	<0.5	8
(WSU Comparison Group)	Total R&D Support	(FY84)		
Washington State	60	1	1.0	4
Oregon State	60	1	2.0	2
U Cal System (Adjusted)	60	1	1.7	3
Michigan State	58	4	0.5	5
Iowa State	54	5	2.5	1

NOTE: Not all universities provided data, therefore rankings were only assigned to those who did. See Technical Appendix for qualifications regarding data collected from each university and for the procedures used to adjust the University of California data.

SOURCES: Campus and associated technology transfer officers; for federal R&D support: "FACT FILE", The Chronicle of Higher Education, February 19, 1986.

Interviews with the technology transfer officials at the two Washington campuses (and comments on the Washington situation from knowledgeable officials at other institutions) tend to confirm the impression from the data that the technology transfer effort in Washington is too modest in scale. There is good reason to think that substantial additional support for technology transfer could be productively used in activities such as:

> arranging for the evaluation of new discoveries and inventions for patent or copyright potential;

> providing faculty inventors with more timely and complete advice and assistance with often highly-complex patent and copyright applications; this long and complex process is often a major deterrent to would-be faculty inventors and the technology transfer offices have been able to provide only limited help;

- > systematically educating researchers about the potential financial benefits to them and their departments of working on and disclosing new inventions and processes, and about the help a better funded office of technology transfer could give with invention evaluation and patent filing;
- > perhaps most important, marketing current inventions to potential licensees and maintaining more general contacts with firms with potential interest in lines of research that could, with industry support and encouragement, lead to inventions in the future; this is an area of activity, according to those interviewed, that has been especially undersupported in the past.

The relatively low-level of invention disclosures, patent filings, etc. in relation to research dollars[14] shown by Table 2 (following page) squares well with anecdotal reports that there is a potentially large pool of untapped possibilities for economically beneficial inventions in Washington's university communities, if only it were to be properly tapped and nurtured.

One might reasonably ask at this point whether there is reason to believe that the two Washington research universities would competently use increased support for technology transfer activities. If past performance trends are any guide (Table 3), there is reason to believe that they would. While there is inevitably some variability from year to year in frequencies when numbers are small, the overall trends seem to be positive. In short, one or two additional staff could probably make quite a difference.

Before leaving this topic, it should be acknowledge that the types of "output" measures shown in Tables 2 and 3 are only intermediate indicators of the ultimate results the state seeks in supporting technology transfer activities. Ultimately, the goal is that inventions, patents, licenses and the like will lead to commercially viable products, increased profits for Washington firms, and new jobs for Washington's citizens. As was indicated earlier, definitive data on such results are not easy to come by, partly because serious technology transfer efforts are quite new and would be expected to take time to lead to marketed products and jobs, and partly because no

[14]Two methodological points may be in order here. First, one might expect the output indicators to lag behind research dollars (i.e., to be affected by levels of research support) by more than the single year implied in Table 2. Perhaps so in some cases, e.g., with respect to licenses and royalty income. But since we are interested here in comparisons across institutions, this would only matter if the "standings" of universities in terms of research support varied much from year to year, which they do not. Second, one might seek to explain the relatively low rank of an institution, say the University of Washington, in terms of outputs per dollar of research support by its mix of invention-rich versus invention-poor fields relative to its peers. But the bulk of inventions, patents, etc. come from engineering and medical schools, where UW research in strong and well-funded. Washington State lacks a medical school, but so do half of the comparable institutions from which data were obtained.

TABLE 2

TECHNOLOGY TRANSFER OUTPUT INDICATORS
FOR WASHINGTON UNIVERSITIES AND COMPARABLE INSTITUTIONS

UNIVERSITY	FEDERAL R&D SUPPORT (FY84)		INVENTION DISCLOSURES (1985)		PATENT APPLICATIONS (1985)		NEW LICENSES (1985)		ROYALTY INCOME (1985)	
(UW COMPARISON GROUP)	$ (millions)	RANK	$	RANK	$	RANK	$	RANK	$ (000s)	RANK
WASHINGTON	137	3	47	5	6	6	11	5	76	7
U CAL SYSTEM (ADJUSTED)	137	3	70	4	28	3	13	3	850	4
MIT	179	1	220	1	75	1	12	4	1000	3
STANFORD	160	2	133	2	42	2	31	1	5000	1
WISCONSIN	100	5	83	3	17	4	1	7	4500	2
MICHIGAN	95	6	45	6	13	5	20	2	581	5
NORTH CAROLINA	48	7	21	7	0	7	2	6	171	6
(WSU COMPARISON GROUP)	TOTAL R&D (FY84)									
WASHINGTON STATE	60	1	13	5	4	4	3	5	9	4
OREGON STATE	60	1	25	2	4	4	5	2	N.A.	N.A.
U CAL SYSTEM (ADJUSTED)	60	1	21	3	9	3	4	3	75	2
MICHIGAN STATE	58	4	17	4	11	2	4	3	2204	1
IOWA STATE	54	5	50	1	21	1	12	1	70	3

Notes: *Not all universities provided data, therefore rankings were only assigned to those who did.
See technical appendix for qualifications regarding data collected from each university and for the procedures used to adjust the University of California data.

Sources: Campus and associated technology transfer officers;
For federal R&D support: "FACT-FILE:", "The Chronicle of Higher Education", February 19, 1986.

great priority is given to tracking paths to results. (Resources for technology transfer activities are, as has been pointed out, already heavily burdened.)

The findings for the Washington institutions certainly suggest that other states could profit from a similar look at their own efforts in supporting academically-based technology transfer efforts.

Table 3

Trends in Technology Transfer Input And Output Indicators At the University of Washington and Washington State University (Fiscal Years)

	Technology Transfer Employees				Patent Applications			
Institution	1980	1982	1985	1986	1980	1982	1985	1986
Univ. of Wash.	0.5	0.5	2.3	2.3	5	10	6	18
Wash. State Univ.	.0	1.0	1.0	1.0	2	2	4	6
	New Licenses				Royalty Income ($000)			
	1980	1982	1985	1986	1980	1982	1985	1986
Univ. of Wash.	3	2	11	16	26	88	76	360
Wash. State Univ.	1	n/a	3	6	n/a	69	9	17

NOTE: See technical appendix for qualifications regarding data collected from each university.

SOURCE: Campus technology transfer officers.

The Washington Technology Center

In addition to the efforts just described to more expeditiously transfer technology already present on the campuses, joint state-industry-university efforts to direct part of the academic research effort toward technology with commercial promise also qualifies as a promising vehicle for increasing the economic returns from state investment in higher education. In Washington, the Washington Technology Center (WTC) is such a vehicle.[15] Broadly similar ventures, generally with larger state funding, have been undertaken in many other states. Established in 1983 as part of the state's "high-technology initiative" of that year, WTC seeks to carefully target its

[15]The Center is based on the University of Washington campus. It also maintains facilities and substantial research programs at Washington State University. Other colleges and universities (including private institutions) are represented on the Center's board but as yet no projects involving them have been funded.

research programs in fields and technologies that have potential economic significance, in particular significance for Washington. Its purposes include strengthening the universities' capabilities in these areas, as well as producing new technologies of immediate commercial interest.

The Center seeks to carry ideas for new commercializable technologies through the "experimental proof of concept" stage, then to transfer the technology to industry for further development. Thus, as is appropriate for an academic enterprise, its projects typically have a longer time horizon to product development and somewhat higher risks than projects normally undertaken by industrial laboratories. Also, many of its projects are sufficiently generic to be of interest to more than one firm, a characteristic that also harmonizes well with the Center's effort to be a useful resource for small firms that cannot afford sophisticated in-house research capability. A very important part of the Center's strategy for accomplishing these ends is to "leverage" the state funds it receives with research funds from industry and the federal government. The idea is to both increase the amount of research that can be supported and tie the Center's programs more closely to industrial interests and needs.

If a program of technology-oriented research is to help a state's economy significantly, it must plan the use of its limited resources very carefully so as to target them at a limited number of specific fields where: (a) the state's institutions are strong relative to the competition or can be made so quickly at acceptable cost; and (b) there is substantial interest among locally-based firms, or strong prospects of attracting interested out-of-state firms to locate in the state in order to be close to the research site. If the program's dollars are spread too thinly across research fields or are spent in fields where other universities are far ahead, both the scientific and economic impact is likely to be limited. Also, such a program is likely to benefit from extensive input from industry as to what fields and projects are of interest to them. If industry input is limited, the program may be too dominated by academic priorities that are out of touch with industry interests. Ultimately, such a development would likely undermine the Center's support base.

Although a detailed review was beyond the resources available for this study, the Washington Technology Center's initial and ongoing strategic planning processes do seem to meet these desiderata. First, the Center's research programs are limited to seven areas[16] so as to permit the application of sufficient funds to each

[16]The seven research program areas are:

to establish a "critical mass" (Washington Technology Center 1986b: unpaginated). Also, the evolution of the Center's research plans and programs evidence attention to potentially fruitful interactions and complementarities across program areas, a willingness to redirect resources from less-to-more-promising research thrusts within the program areas (determined on both scientific grounds and by ability to attract industry support), and even to reorganize an entire program area.[17] The areas of research emphasis were initially selected by a process that included both extensive input from Washington industry[18] and an apparently thorough assessment of the comparative strengths of Washington's universities. Within the research areas identified by the Center's long-range planning process, proposals for individual projects are solicited each year from researchers on the campuses of the Center's participating universities. There is an internal scientific peer review process as well as review by advisory councils and a Research Committee with both industry and academic membership. Of course, ability to attract federal and industry support also provides both scientific and "market" tests. (Data on this dimension will be presented shortly.)

We can claim no expertise in the substantive fields of the Washington Technology Center's research, so we cannot judge its projects' scientific or commercial promise specifically. The Center does employ well-designed processes for strategic planning, and seems to have a clear sense that it cannot try to do everything at once. The Center leadership seems to be aware of the need for frequent assessments of progress and direction in the rapidly-changing, highly-competitive arenas in which it works. (It is significant in this connection that the Center has avoided hiring a large research staff with specific expertise, but instead hires most personnel, largely students

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> advanced materials technology
> compound semiconductor technology
> gallium arsenide integrated circuits and integrated optics technology
> manufacturing technology
> medical biotechnology
> microsensor technology
> plant biotechnology (WTC 1986a: 13)

[17]One program area reorganized was the plant biotechnology program, created out of the original crop plant biotechnology program based at Washington State University and the forest products biotechnology program based at the University of Washington. Substantial redirection of effort has also occurred in the computer systems and software technology program (toward computer-aided systems design) (WTC 1986 a:13-19, and interviews with Center leadership). Such programmatic redirection can, of course, be read as a sign of failure, but it should be emphasized that some initial misjudgments are inevitable in an enterprise such as this one. Probably most important in the long run is whether the mistakes that do occur are caught early and corrected.

[18]Fourteen of the Washington Technology Center's 25 board members are from industry. The Center's broad areas of research thrust are identified and researched by its Long Range Research Planning Committee (LRRPC), which also has strong industry representation. Every two years the LRRPC conducts an industry/university workshop to solicit input about research directions from representatives of interested companies. Some 200 people participated in the 1986 session (WTC 1986a: 13-14).

and faculty, on a project-by-project basis.) Finally, the Center's provisions for extensive and strategically-placed input from industry, as well as its solicitation of financial stakes from the private sector, provide some insurance against any takeover of the Center's programs by grandiose academic visions with little clear economic payoff for Washington. On the other hand, the Center's campus base and broad academic participation should help insure that the activities it supports are truly of a generic research nature, not merely product development or other work more appropriate for a company-funded laboratory.

Next, we turn our attention to more tangible indicators of the Washington Technology Center's progress toward state economic development goals. First, it is important to note that the Center has been in existence only four years and that its key objectives necessarily have long time horizons. Building excellence in technology-oriented fields, educating the next generation of leaders in such fields and creating new products and jobs are goals that take time to achieve. Nonetheless, it is important that preliminary progress indicators be developed and monitored in the meantime to guide those who must decide about commitments of resources. We will now examine the evidence from such indicators as have been developed by WTC or that we were able to construct from data it collects.

The best-documented in-progress indicator is also one of the most useful -- the level of other support "leveraged" by the State's support of the Center's research programs and operations. The Center's data on this, by program area, are reproduced as Table 4. Assuming the validity of the data, the Center's performance on this score is noteworthy. In the 1983-85 biennium, the State provided $1,377,000 in operating support and $1,468,000 in capital funds (not shown in Table) to the newly-established Center. In addition, the Center attracted $396,000 in federal awards and $1,963,000 in industry support (including a small amount of capital support) in its initial biennium. Thus, the ratio of total nonstate support to total reported State support was .83 (High Technology Coordinating Board 1985a and WTC 1986a: 15), while the ratio of operating support from nonstate sources to state support for operations (probably a better indicator, since capital facilities last many years) was about 1.61 (Washington Technology Center 1986a: 13).

Figures for the 1985-87 biennium show industry and federal support of $15.55 million, compared to state support of $3.6 million, a ratio of nonstate to state funding of 4.3 to 1. For FY1986, just 29 percent of the Center's expenditures were funded by the state, with industry providing 45 percent and federal agencies 26

TABLE 4

THE WASHINGTON TECHNOLOGY CENTER'S SUCCESS IN LEVERAGING FUNDS
(Operating Funds Only; Thousands of Dollars)

	1983-85 BIENNIUM		1985-87 BIENNIUM			1987-89 BIENNIUM
				Non-State Awards		
	State Expenditures	Non-State Awards	State Appropriation	Year 1	Year 2	State Appropriation
PHYSICAL SCIENCE AND ENGRG						
Microsensor Technology	457.8	840.5	600.0	604.3	588.3	595.2
Compound Semiconductor Technology	106.8	374.8	350.0	859.9	1,546.0	793.5
Computer Systems/Software	82.0	50.0	154.8	39.7	372.4	793.5
Manufacturing Technology	46.0	335.9	550.0	318.2	1,124.4	694.4
Advanced Materials	33.0	564.3	516.1	3,959.0	1,964.7	1,488.0
Sub-Total	725.6	2,165.5	2,170.9	5,781.1	5,595.8	4,364.6
BIOTECHNOLOGY						
Medical Biotechnology	130.0	0.0	411.5	1,727.3	1,110.6	892.8
Plant Biotechnology	126.6	50.0	320.0	646.4	657.7	396.8
Sub-Total	256.6	50.0	731.5	2,373.7	1,768.3	1,289.6
EXPLORATORY RESEARCH PROJECTS	104.4	0.0	127.6	36.2	0.0	0.0
TOTAL RESEARCH PROGRAM	1,086.6	2,215.5	3,030.0	8,191.0	7,364.1	5,654.2
TECHNOLOGY ASSISTANCE PROGRAM (TAP)	0.0	0.0	80.0	0.0	0.0	297.6
ADMINISTRATION	290.2	0.0	495.0	0.0	0.0	992.0
TOTAL OPERATING BUDGET	1,376.8	2,215.5	3,605.0	8,191.0	7,364.1	6,943.8

SOURCE: Washington Technology Center (1986a: 15 and data provided by the Center, 1987).

percent. For the 1985-87 biennium as a whole, state appropriations represented less than 20% of the Center's total operating expenditures. If the 1987-89 biennium's figures follow a similar pattern the state's almost-$7 million allocation to the Center would yield nearly $30 million in nonstate funds.

In short, these data suggest that the Washington Technology Center has the ability to leverage its basic state support to attract other funds for its research programs. This is one test of both the scientific merit of theCenter's research programs, particularly evidenced by the federal awards most of which are based on rigorous peer review, and of their commercial promise as shown by the industrial support (though other explanations for generous early industrial support are not inconceivable). The federal dollars and the part of industry support (roughly one-fourth) that comes from out-of-state companies (or would otherwise be spent out-of-state by Washington firms) has immediate economic significance in that it brings new purchasing power and thus demand for labor into the state.

Another useful type of indicator that the Center was doing useful work and would likely have a long-term impact on technology transfer to industry would be the number and level of involvement of various types of personnel (e.g., industry scientists and engineers, graduate students, faculty, etc.) in Center research projects. The Center's data on this are limited, but they do show a rapid growth in employed personnel from three full-time-equivalents in FY1984 to 74 FY1986. Table 5 shows how these break down by types of personnel charged to the Center's budget, but does not give any indication of involvement by industry personnel.

The data show that 17 regular faculty and 125 students (headcount research assistants plus hourly staff) were involved with the Center in 1986, and no doubt a substantial fraction of these increased their awareness of industrial research interests and needs, and perhaps made enduring contacts with industry personnel, as a result. We have emphasized before that establishing such professional/personal networks across the two sectors seems to be a key factor in productive technology transfer programs. Thus, data on industry as well as academic personnel involvement would be a useful in-progress indicator of the Center's likely ultimate impact that should be collected and report regularly.

Table 5

Washington Technology Center
FY1986 Employment by Type of Employee

	# of Persons	Equal to Full-time (FTE)
regular faculty	17	10
research faculty	5	4
research assistants (students)	63	34
classified staff	20	8
exempt staff	7	6
hourly staff (students)	62	12
TOTAL	174	74

SOURCE: Washington Technology Center (1986a: 13).

After just a bit more than three years, it is not realistic to expect even a technology-oriented research program like the Washington Technology Center to have created large numbers of new jobs as a result of its efforts. In most fields the time from the Center's "experimental proof of concept" stage through product and market development (not to mention financing) to active production for sale is likely to be anywhere from two or three to ten or more years. Still, through 1986 the Center claims that its technology is directly responsible for 18 new jobs (17 in the $15-30 per hour range), mostly jobs for scientists and design engineers (WTC, 1986a: 9).[19] These "early-stage" employees could, of course, be the precursors of many more and more diverse types of workers if their product development efforts are successful.

With only a brief life to date, the Center was not able to supply trend data on such useful intermediate indicators of impact as inventions, patent filings and the like, licenses negotiated and royalty income. WTC argues that these are not complete measures of the economic potential of its activities, which is certainly true. However, they are useful and widely-accepted indicators and such in-progress indicators are much needed when substantial investments from public authorities are requested in the name of promised large long-term benefits. Thus, data on such indicators should be developed and reported regularly.

In summary then, at this stage the Washington Technology Center's economic impacts on the state already appear to be significant and the prospects for the future appear promising. Most significant, the Center's data indicate an ability to attract substantial funding from Washington firms as well as to bring out-of-state

[19]The reader should note that we did not attempt to verify independently WTC's claims regarding employment generation.

dollars into the state. The volume of industrial investment suggests that the private sector expects the Center's research to have commercial payoff, which is the first test of the appropriateness and potential of its research programs. These programs, however, must continue not only to attract new industry and federal dollars, but also to show increasingly concrete evidence that they are leading to job-creation and economic growth in Washington to win continued state support. Also, the Center needs to give careful attention to ways in which it can more widely distribute its activities and impacts around the state. This brings us to the important matter of the impacts and potential impacts of higher education on economic development in rural areas.

Higher Education and Rural Economic Development

A serious problem with the approaches just discussed is their limited applicability to a large part of the State of Washington--i.e., to small rural communities.[20] The existence of "dual economies," one relatively prosperous and growing (the urban/suburban complexes), the other (the rural parts of the state) declining or at best growing much more slowly, is a problem common to many states. It has important effects on the politics of higher education.

In general, rural economies tend to benefit less than urban areas from broad programs of increased support for higher education, even if these have an economic development bent, for rural economies are different from their urban counterparts. Programs like those suggested above, which tend to fit institutions in the metropolitan setting best, thus do not necessarily attract much support from rural-area legislators, whose primary concerns are the tax burden and programs that can help their constituents directly. To begin with, the geographic distribution of academic institutions and business firms inevitably favors urban areas (for quite logical reasons). Increased state budget support for isolated institutions may permit increased enrollments (although it does not guarantee them) but graduates will not stay in these areas, however pleasant they may be, without appropriate jobs and career opportunities. Unfortunately, these have been declining for seven or eight years in most of the rural Northwest because of persistent, probably permanent, problems in the staple agriculture, forestry, fishing, and mining industries. Again, similar problems plague rural areas in many other parts of the country.

[20]Rural areas are defined here to exlude areas within ready commuting distance of urban population and employment centers.

Thus, education efforts must be linked to more direct job-creation strategies if they are to help rural areas much. But the requirements for effective job creation strategies are somewhat different in rural areas as compared to urban areas and not necessarily similar for all rural areas. Such strategies must be carefully tailored to the specific context. But, realistically, some rural areas simply do not have much economic development potential in the forseeable future because of such factors as lack of raw materials, distance from markets, unfavorable climatic conditions, or lack of desirable esthetic features. In sum, educational improvements within the feasible range have at best a supplementary role to play in rural economic development strategies. The driving forces determining which regions prosper and which do not are largely exogenous. In many cases there is some role for local leadership that is visionary and pragmatic at the same time--and perhaps above all, persistent--and this must include the education sector, but it must clearly encompass much more as well.

Finally, some rural areas, even those with some economic development potential, are not well-served by the existing distribution of postsecondary educational institutions and are not likely to be in the forseeable future. (This is strikingly true in Washington, Oregon, and Idaho.) "Distance learning" efforts and off-campus instructional programs that escape the often-stringent state controls on such enterprises could help to reduce the educational deficit among the population in these areas, but by themselves will not do much to create economic development.

In this part of the paper, the goal will be to outline some basic desiderata for rural economic development strategies involving higher education based upon preliminary findings from research in three states of the Pacific Northwest (Washington, Oregon, and Idaho). Most though not all of the strategies explored below (in the section following the next one) are drawn from the six types described earlier. The section immediately below focuses on key characteristics of rural economies as these relate to the emerging world economic structure.

Essential Characteristics of Contemporary Rural Economies Relevant to Economic Development Strategy

Most rural economies are based upon resource extraction in one form or another (farming, forestry, fishing, mining). Production of such raw commodities, whose prices fluctuate sharply with economic cycles, has always been associated with some volatility in rural economies. This vulnerability has been considerably enhanced in recent years by the increased internationalization of the U.S. economy. Moreover, in agriculture the

long-term trend has been toward replacement of farm labor by capital equipment and new technology. Since 1980 this trend has accelerated and has also hit the timber and wood products industries--staples of the rural economy in the Northwest--very hard. Significantly in terms of its long-term implications, both farm and forest output in Washington have fully recovered from depressed early eighties levels, but employment in these sectors is dramatically lower than seven years ago (off about one-third in the forest products industries) with virtually no chance of staving off further declines (Leman 1988, forthcoming). The reason is that to remain competitive in the demanding international markets they compete in, these industries have had to make massive substitutions of capital and cost-saving technology for labor. Mining and fisheries are much smaller industries in most locations, face somewhat similar problems to agriculture and forestry, and also face the limitations imposed by the potentially exhaustible supplies of the resource. All this means that the traditional sources of job and economic growth in many rural areas are unlikely to perform in this fashion in the future (Leman 1988, forthcoming). New sources of job growth must be found or these areas will suffer population and economic decline.

Unfortunately, the fastest growing sectors of the modern economy generally do not find rural areas as attractive as urban, either as locations to which to move or as sites for new firm start-ups (Malecki 1987). One such sector is wholesale and retail trade and services, a rapidly growing employment sector nationally. But this sector thrives on dense concentrations of people and growing population, conditions which do not characterize rural areas. Indeed, trade centers are moving increasingly to larger towns and cities from the smaller rural towns (Smith and Redfield 1987) as improved transportation and communications make this possible and competitive cost pressures make it necessary. In any case, wholesale and retail trade and services use a low proportion of highly-trained and educated workers.

The high-paying, fast-growing producer services industries (services provided to firms and government agencies such as accounting, insurance, and financial services, research and development, computer-related services, management consulting and the like) require lots of educated workers but have so far preferred to locate in urban areas near the bulk of the clients they serve. They also seem to prefer metropolitan locations because of their proximity to academic institutions that supply them with a selection of entry-level employees, as well as continuing education opportunities and access to consulting assistance (Beyers et al 1986).

Modern transportation and telecommunications capabilities could theoretically make it feasible for some

of these key, high-growth firms to locate at least some (i.e., especially "back office") operations in rural areas (Dillman 1985). However, in many cases large public investments in roads, airports, and telecommunications infrastructure to make private telephone lines and sophisticated computer hook-ups possible would be necessary to attract these firms. Costly improvements in educational access and quality would probably also be required. Even so, a major problem would remain in that most educated workers have a strong preference for urban or suburban areas (or close-in rural areas that have been excluded here by definition).

Somewhat similar to the producer services firms are the "high-tech" R&D-oriented product companies, which have experienced rapid employment growth in recent years and tend to spin off innovative new firms that produce more jobs (Armington et al 1984; Malecki 1987). In spite of less need to be close to raw materials and/or markets than traditional manufacturing enterprises, these firms have also tended to strongly favor certain metropolitan environments (Office of Technology Assessment 1984; Malecki 1987). A key reason for this seems to be the "agglomeration economies" associated with some large urban areas that have, in addition to ready access to business services, a network of experienced entrepreneurs, access to venture capital, an "entrepreneurial climate" and, critically, high-quality research universities and a large scientific and technical labor pool (OTA 1984; Malecki 1987). No one or two of these ingredients seem to be adequate by themselves to create a "seedbed" for these innovative firms.

Occasional efforts to stimulate high-technology development in rural areas by such means as public R&D investments seem to have been generally unsuccessful (Malecki 1987). Low labor costs in rural areas have been attractive to high-tech manufacturing plants (as contrasted with headquarters operations, R&D facilities, and prototype production plants which generate most spinoffs), but these employ few highly-educated workers and tend to be "footloose"--often moving offshore for truly low labor costs.

Traditional manufacturing industries did move a significant amount of branch-plant production activity to non-metropolitan areas in the 1970s, mainly to take advantage of low labor costs (Leman 1988, forthcoming). But the sharply increased competition of the '80s has been associated with serious losses for rural areas as labor-intensive manufacturing has increasingly moved offshore. For much manufacturing of heavy goods remaining in the United States the classic reason for locating in urban centers still holds--proximity to markets and to transport facilities for reaching other large urban markets.

Broadly speaking then, where rural areas, or at least certain of them, have a comparative advantage, it is usually in one of two broad areas. One is tourism, success in which is usually grounded in local esthetic, cultural, or climatic amenities, and can rarely be created without these endowments. The second is manufacturing industries tied to the natural resource base, such as specialty crop production, food (including fish) processing and wood and metal product processing and manufacture, which supplement existing extractive activities. As a supplement to these (and sometimes not even tied to the primary local products), low labor and overhead costs can make possible the development of small-scale, labor-intensive specialty craft and other product manufacturing (such as Appalachian Mountain crafts), often carried out by minimal-overhead, home-based firms. The advent of mass marketing via direct mail and telecommunications greatly reduces the problems posed by remote location and makes much more of this type of activity economically feasible. The financial rewards do not seem to be very great in most cases, but they may be enough to sustain people who do not want to leave rural areas or as second income sources for farm families, tourist-facility owners and the like.

Modest growth in these potentially viable sectors can bring into the rural community new wealth ("export earnings") that can in turn support some growth in the local service sector and its employment. Of course, each rural area's economic niche may be different and may not be easily discovered. Indeed, many communities may be viable in the modern, internationalized economy only at substantially less than their current population size.

The Role of Higher Education

Unless one rejects the premises of the above line of (essentially geographically-based) argument, one must conclude that the role of higher education in rural economic development is generally going to be a limited one. This is all the more true if we accept also that few states will be building new campuses readily accessible to rural areas in the foreseeable future. Nonetheless, there are modest contributions existing colleges and universities can make, though they require help from other sectors of the rural community and, in most if not all cases, new state dollars. These, of course, may be hard to come by.

One obvious step institutions could take, but in most cases only with explicit state encouragement and funding, is to increase efforts to reach remote rural areas with education and training programs. While the technology for beaming instruction from campuses to remote sites exists, substantial capital investments remain to be made in most states before the promise here can become a reality (Dively 1987). In addition, institutions

could take more live, off-campus instruction to isolated rural areas if they had financial incentives to do so, but the trend in terms of state support for such high-cost-per-student, off-campus programs seems to be just the opposite. (See, for example, Washington Higher Education Coordinating Board 1987). In any case, as has been emphasized before, the impact of new instructional efforts on rural economic development will generally be slight in the absence of complementary job-development efforts.

Customized, often state-subsidized job training programs for specific employers run by community colleges, and to some extent other postsecondary institutions, are a part of many states' economic development programs. (See, for example, Jaschik 1986). Some of the generic difficulties with these programs were considered earlier. In Washington, the State's Job Skills Program uses postsecondary institutions (mostly community colleges) more than any other type of training provider (Washington State Commission on Vocational Education 1986). This four-year-old program seems to be reasonably successful in training and placing people in jobs (though employer demand is surprisingly limited), but only a small percentage of the jobs are with employers in rural areas. Evidently, the mere presence of state training subsidies is not a major plant location factor working in favor of rural areas, and existing employers there are not growing fast enough to have large training needs.

Some job training has been provided to workers in communities in the Pacific Northwest through dislocated worker assistance programs. Higher education institutions (again mostly community colleges) have played a modest but useful role in some of these programs in Washington and Oregon, but the problem of mismatch between where the workers are and where the jobs are remains.

For the fundamental reasons of economic geography already discussed, it seems unlikely that technology transfer efforts of the traditional type or of the type represented by the Washington Technology Center's research programs will often impact rural areas very substantially. This supposition is currently being tested in Washington as the Washington Technology Center endeavors to spread the benefits of its technological advances widely throughout the state through a new Technology Assistance Program, which identifies its potential clients with the aid of local groups such as the state-designated local economic development organizations. In a related vein, Washington State University, located in the isolated small town of Pullman near the Idaho border, has initiated a research park and incubator venture in the campus area, which will seek to lure and nurture

technology-oriented businesses interested in proximity to the WSU campus. It will be instructive to see how these ventures fare in the difficult task of stimulating economic development in rural areas.

The campus-based business assistance network proposed earlier has some applicability to the problems of rural areas, though the distances between centers of economic activity make these areas substantially more costly to serve than metropolitan regions. The Small Business Development Centers (SBDCs) mentioned before are based at many two- and four-year campuses throughout the Northwest (and the country), including a number located in relatively isolated places. These can be funded and organized to offer low-priced entrepreneurship training for small business owners and would-be entrepreneurs, as well as to provide subsidized consulting (termed "counseling" in SBA jargon). These programs have strong incentives to see that their courses and services are practical and oriented toward the local business person's situation. In the rural areas this means they must be focused on, or at least take account of, the special problems and challenges of doing business in an area that may be far removed from markets and desirable support services.

Some collegiate business -- and to a lesser extent engineering and technology -- programs also emphasize innovation and entrepreneurship in their regular academic degree programs. Since much of this type of economic activity is located in urban areas, so are most of the degree programs in this field, but there are exceptions even in the Northwest. One vehicle for expanding the impact of such academic endeavors is the Small Business Administration's Small Business Institute (SBI) program, which subsidizes faculty-supervised small business consulting efforts by students. Another is direct state support for expanding both teaching and service (or even research) programs in entrepreneurship and business management in small towns and rural areas. Central Washington University, located in the town of Ellensburg on the east slope of the Cascade Mountains, has taken advantage of both SBI and, recently, supplemental state funding to support and expand a widely-acclaimed program of aid to area businesses.

The effects of such efforts on rural job creation and other economic development indicators are not well documented. They are in all likelihood positive but modest (though this supposition badly needs sophisticated, long-term evaluation). In any case, it must be remembered that the resources used in these programs have opportunity costs: perhaps the same dollars could create more jobs elsewhere. The argument for using them for rural development will probably always be primarily an equity-based one.

There is another relatively attractive possibility for addressing the basic rural economic development problem (i.e., job creation) for colleges that have the capacity or are willing to develop it. This approach involves working in a team effort with local community, business, and labor groups in the formulation of locally-tailored strategic plans for economic development. Sometimes the academic institution may need to be the initiator but it can never do the whole job by itself for reasons that should be fairly obvious. Plans developed may encompass efforts to better market existing products and retain and nurture existing firms, as well as measures to develop or attract new firms or lines of business. As the analysis in the previous section suggested, successful strategies will often focus on natural-resource-related enterprises, tourism development, and nurturing home-based businesses.

Land-grant-university-based cooperative extension units have successfully assisted in such efforts in some communities. For example, the Jackson Area Extension Center at Ohio State University has developed an evidently sucessful survey-based approach to business retention and expansion for small communities through business climate analysis and improvement. Students and volunteers do much of the data collection and assist faculty and professional staff with analysis and work on strategy development. Thus the program builds upon academe's strengths in terms of data collection and analytic expertise, and, since the work has educational value, can use low-cost student labor.

State officials in Washington are looking at this type of program with some interest. Possible vehicles for mounting it include Washington State University's Community Resource Devlopment unit in Cooperative Extension and/or WSU's Partnership for Rural Improvement (PRI), both of which have statewide networks of personnel with potentially relevant expertise. They also have track records of reaching out successfully to individual small communities in economic-development-related ventures in the past.

For such ventures to be sustainable from the academic institution's perspective, the work involved must be perceived as educational, as well as socially worthwhile, and almost certainly requires some explicit financial support. Importantly, this type of effort shares with entrepreneurship education and business consulting the possibility for integration with at least some parts of the regular academic program, as well as the potential to actually expand the level of economic activity in a rural community. Of course, expectations on this last front should be appropriately modest and not too focused on the short-term.

Conclusion

There are a number of ways in which colleges and universities can assist in state and community economic development. It seems likely that substantial additional efforts in this direction could be achieved with fairly modest additional resources because there is considerable academic interest in this area now and because there is substantial potential to integrate economic development-oriented activities into ongoing teaching, research, and service programs. Moreover, faculty, students, and institutional facilities usually have both some slack time not devoted to their usual pursuits and need for additional income. This helps to keep down the price required to elicit their services. Yet, it is unrealistic (and undesirable) to expect much increase in academic attention to economic development concerns without some increased resources.

The range of types of possible economic development efforts run the gamut of academic functions from teaching to research and service/consulting efforts. Which should take precedence depends of course on the strengths of the institution and the needs of the relevant community. Most research universities can profitably conduct more research of mutual interest to academe and industry than has been the norm in the past, and can do more to facilitate industry access to and commercialization of research results. They can also facilitate continuing education for industry scientists, engineers, and managers. Community colleges can assist state and local economic development efforts by providing job training and retraining for current and prospective labor market needs, and, in some cases, by offering business management and entrepreneurship courses. But both types of institutions need to be wary of the perils of trying to do things industry could and should do for itself.

Four-year institutions other than research universities can sometimes perform useful applied research and workplace-oriented education and training, but their comparative advantage in regard to economic development may be in the area of public service: consulting for individual firms and consulting and staffing team efforts at developing community economic development strategies, particularly in rural areas. All institutions and policymakers, however, would do well to remember that the largest contribution of academic institutions to economic development in the long run is almost certain to occur from their continued primary attention to performing their basic teaching and research functions well.

Large-scale new state support for higher-education-based economic development activities will not be

easily achieved in most states. This is particularly significant for rural areas, which need the most help but do not necessarily get it in the normal competition for higher education resources or even from the most common approaches to enlisting higher education in state economic development efforts. Given the existence of powerful economic forces beyond their control, there is a limit to what institutions in rural areas can do for their local economies but at least some specifically rurally-oriented types of efforts hold out modest promise. In any case some state support for programs to aid rural communities is justified on equity grounds. (There is also a closely related political rationale).

Nonetheless, equity and political considerations aside, after surveying the literature in this field one is compelled to call for more serious attention to objective data collection and evaluation of the impact of increased economic development efforts. Here is a place where knowledgeable scholars can function in their sometimes-neglected role as objective policy analysts and social critics. If we do not, who will?

TECHNICAL APPENDIX FOR TECHNOLOGY TRANSFER DATA TABLES

(Tables 1-3)

R&D SUPPORT: Some universities (e.g., MIT and Iowa State) receive millions of dollars in federal funds for special-purpose laboratories that are associated with the campus. These dollars are excluded from the reported federal research dollars in the tables because they produce very little commercial technology transfer activity. Washington State and its peers are compared on total rather than strictly federal research funding because nonfederal research dollars are a substantial part of their total research support, unlike for UW and its peers.

LICENSES: Copyrights are not included; thus, software "inventions," a growing area of on-campus activity, are not shown.

FISCAL YEAR: All institutions reported data on a July 1 - June 30 fiscal year basis except Michigan State University, the University of North Carolina and Stanford University, which reported on a calendar year basis.

IOWA STATE UNIVERSITY AND UNIVERSITY OF WISCONSIN: These two universities rely solely on private foundations legally independent of the university for the technology transfer function. The employee and budget data reported in the tables for these institutions come from the foundations. entries for the other universities represent expenditures by the institutions themselves. These other institutions, including the Washington universities, rely on independent foundations or other contractors for some patenting and licensing functions, but, because of the diversity of these arrangements, we were unable to get comparable data on their personnel and total expenditures. Our best estimate is that the personnel and expenditures as reported in the tables are at least roughly comparable across institutions.

MIT: Data are estimates from John Preston, MIT's technology transfer director, but are believed to be within five percent accuracy.

UNIVERSITY OF CALIFORNIA: Technology transfer operations within the nine-campus University of California system are largely centralized at systemwide headquarters in Berkeley, making valid comparisons using individual UC campuses impossible. The systemwide office was unable to provide us with data on their campus-level operations, so the figures reported in the table understate the number of

employees and total expenditures on technology transfer. The adjustment of the University of California data referred to in the tables involved simply scaling the raw UC data (on both the input and output indicators) to take account of this multicampus system's much larger volume of R&D support as compared to either of the individual Washington campuses. For the comparison with the University of Washington (there are two UC campuses on the OFM list of UW peers), the gross UC figures were reduced by a factor (multiplier) equal to the fraction the University of Washington's federal R&D support in FY1984 represented of the University of California's federal support (i.e., $137 million/$490 million). Thus, the table shows UC's federal R&D support and technology transfer input and output indicators adjusted to the University of Washington's federal support level of $137 million. A comparable procedure was followed to compare Washington State University to the University of California system (which includes one OFM peer -- UC Davis), but, since WSU has a large proportion of nonfederal R&D support (the same is true for WSU's peers in this table), its total R&D support was compared to UC's total support to derive the scaling factor (i.e., $60.5 million/approx. $700 million).

UNIVERSITY OF NORTH CAROLINA: Data on patent applications were not available, only on patents awarded. Thus, we estimated patent applications from the data on patents awarded by using the national average relationship between awards and applications from university-based filers.

UNIVERSITY OF OREGON: The university does not have an engineering or a medical school; this helps explain the low level of federal research support.

WASHINGTON STATE UNIVERSITY: There is no formal technology transfer office; the one full-time employee performs the technology transfer activity on campus as well as performing other duties.

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Zumeta, William and Dean Stephens. Increasing Higher Education's Contribution to Economic Development in Washington, Olympia, WA: Washington State Institute For Public Policy, December 1986.

INTERVIEWS

Name	Affiliation	Date (all 1986 except) where otherwise indicated)
Lyle Anderson*	Washington State Director, Small Business Development Center	Oct, 1986 and Aug, 1987
Norman Arkans	Assistant Vice President, University Relations University of Washington	Nov
James Barron*	Economist and former Director, Community Resource Development Program, Washington State University Cooperative Extention	August 1987
Spencer Blalock	Technology Transfer Officer Iowa State University Research Foundation	Aug-Sept
Terry Bowman*	Administrator for Economic Development, Idaho State Department of Commerce	August 1987
Henry Bredeck	Technology Transfer Officer, Michigan State University	Sept
Howard Bremer	Technology Transfer Officer Wisconsin Alumni Research Foundation	Aug-Sept
David Broome	Technology Transfer Officer, University of North Carolina	Aug-Sept
Jack Brummel*	Staff Counsel, Commerce and Labor Committee, Washington State Senate	July 1987
Connie Charlton*	Administrative Staff, Idaho Small Business Development Center	August 1987
Thomas Croft*	Project Director, Seattle Workers' Center	July 1987
Jack Daray*	Associate Executive Director, Washington State Higher Education Coordinating Board	August 1987
Ray Davidov*	Director, Small Business Institute, University of Washington	July
Roger Detsell	Technology Transfer Officer, University of California	Sept
Crystal Dingler*	Manager, Office of Technology Transfer University of Washington	July-Oct
Dwight Dively*	Policy Analyst, Washington State High Technology Coordinating Board	June
Robin Dodson*	Deputy Chief Academic Officer, Idaho State Board of Education	August 1987

Kirk Dumheller*	Manager Industrial Programs, Battelle Pacific Northwest Laboratories	Sept
Jerry Ellis	Business and Government Relations Director Department of Trade and Economic Development	Aug
Fred Erbisch	Technology Transfer Officer, Michigan Technological University	Oct
Wayne Fairburn	Chairman, Business Administration, Central Washington University	Sept
Richard Finholt*	Director, Ohio State University's, University Research Park	Sept
Brad Foltman*	Senior Financial Management Analyst, Idaho Division of Financial Management	August 1987
Ronald Fowler*	Small Business Assistance Programs Coordinator, Washington State Board for Community College Education	Oct
Becky French	Technology Transfer Officer, North Carolina State University	Sept
Robert Gavin	Technology Transfer Officer, University of Michigan	Sept-Oct
James Hawkins*	Director, Idaho State Department of Commerce	August 1987
Robert Hester	Administrator, Small Business Institute for Seattle's Community Colleges	Sept
Sally Hinds	Technology Transfer Officer, Stanford University	Aug-Sept
William Hostetler	Patent, Trademark, Copyright Officer Washington State University	Sept-Oct
Eric Johnson	Executive Director, Central Puget Sound Economic Development District	Sept
Jack Johnson	Technology Transfer Officer, University of Arizona	Sept
Megan Jones	Director, Massachusetts Centers of Excellence Corp.	June
Lesley Larson*	Acting Director, .Washington Research Foundation	July
Kenneth Lisk*	Program Specialist, Job Skills Program, Washington State Board of Vocational Education	August 1987
H. LeRoy Marlow	Director, Pennsylvania Technical Assistance Program	Aug-Sept
Robert McDaniel*	Director, Office of Community Services, Washington State University	August 1987
Mark McDermott*	Staff Analyst, Commerce and Labor Committee, Washington State Senate	July 1987
Bob McQuate	Technology Transfer Officer, University of Oregon	Oct

George Morse	Community Resource Economist. Jackson Area Extention Center. Ohio State University	July 1987
John Moseley	Technology Transfer Officer, University of Oregon	Sept-Oct
Peter Odabashian*	Director of External Affairs, Washington Technology Center	Sept-Oct
John Pearson	Technology Transfer Network Director Michigan State University	Oct
Low J. Piotrowski*	Education Coordinator, Washington State Small Business Development Center	August 1987
Walter Plosila	Deputy Director, Pennsylvania Department of Commerce	
Lyle Pooley*	Research Director, Idaho Small Business Development Center	August 1987
John Preston	Technology Transfer Officer Massachusetts Institute of Technology	Aug
Sky Records	Assistant Regional Administrator for Business Development U.S. Small Business Administration	Oct
Carol Riesenberg	Research Coordinator, Washington Small Business Development Center	Sept
Robert Roseth	Director, Information Services, University of Washington	Oct
Eric Rude	Dean of Research, University of Wisconsin	Oct
Kim Smith	Technology Transfer Officer, Oregon State University	Sept
Richard Speering*	Executive Director, Idaho State Board of Education	August 1987
Edwin Stear*	Executive Director, The Washington Technology Center	Sept
Harriet Stevenson	Director, Small Business Institute, Seattle University	Nov
William Stimson	Information Officer, Washington State University	Oct
Roger Tollefson	Director, Pennsylvania's Ben Franklin Partnership	Sept
Bill Tompkin	Arizona Department of Commerce	July
Robert Waldo*	Executive Director, Council of Presidents	Nov-Dec
Cebe Wallace	Management Assistance Officer, Seattle Office, U.S. Small Business Administration	Oct
Jim Wills	Grant and Research Development Officer Washington State University	Sept-Oct
Patrick Woods*	Staff Analyst, Commerce and Labor Committee, Washington State Senate	July 1987

Holly Zanville	**Vice Chancellor, Oregon State System of Higher Education**	**Aug**

Personal Interview; others are phone interviews.